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WAR DEPARTMENT

[U.S. Dept. of army]

TECHNICAL MANUAL

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ORDNANCE MAINTENANCE

GENERATING UNITS M5 AND M6

1 AUGUST 1943

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TECHNICAL MANUAL
No. 9-1616

WAR DEPARTMENT
Washington, 1 August 1943

ORDNANCE MAINTENANCE

GENERATING UNITS M5 AND M6

Prepared under the direction of the
Chief of Ordnance

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*This manual supersedes TM 9-1616, dated 1 March 1942; TB 1616-1, dated 25 August 1942; and TB 1616-2, dated 11 November 1942.

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Section I

INTRODUCTION AND SCOPE

Paragraph

Scope 1
Differences in manufacture 2
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1. SCOPE.

a. This manual is published for the information and guidance of ordnance maintenance personnel. It contains detailed instructions for inspection, disassembly, assembly, maintenance, and repair of the Generating Unit M5 (including differences between M5 and M6), supplementary to those in the Field Manuals and Technical Manuals prepared for the using arms. Additional descriptive matter and illustrations are included to aid in providing a complete working knowledge of the materiel.

2. DIFFERENCES IN MANUFACTURE.

a. These generating units have been assembled by different manufacturers who have used standard parts made by still other manufacturers. Working drawings have been furnished by the Ordnance Department. Similar parts will be found reasonably interchangeable regardless of where they are made. A metal plate is mounted on the instrument panel door of each unit, carrying the name of the manufacturer or prime contractor responsible for the construction of that particular unit. If required to make a record of this, be sure to copy the name exactly as it appears, because firm names are sometimes similar. For example, Units M5 have been made by the Hobart Manufacturing Company and by the Hobart Brothers Company, two entirely unrelated companies, both in Troy, Ohio.

3. DESCRIPTION AND CONSTRUCTION.

a. General. This unit is a self-contained power plant consisting of three main units: gasoline engine, power generator, and switchboard. These units are mounted on a welded steel frame, which also serves as a skid when the unit is moved. The unit is completely enclosed by a sheet metal housing. The radiator end of the unit is considered the front, and the main generator end, the rear. Right and left sides are determined from the rear, facing forward. Hinged hoods on the sides and a vertically hinged door on the rear of the housing give access to the engine, generator, and instrument panel. A sheet metal battery cover on the lower front part of the housing is easily removed for the purpose of servicing the battery (fig. 1). The canvas instruction book holder is on the inside of the instrument panel door

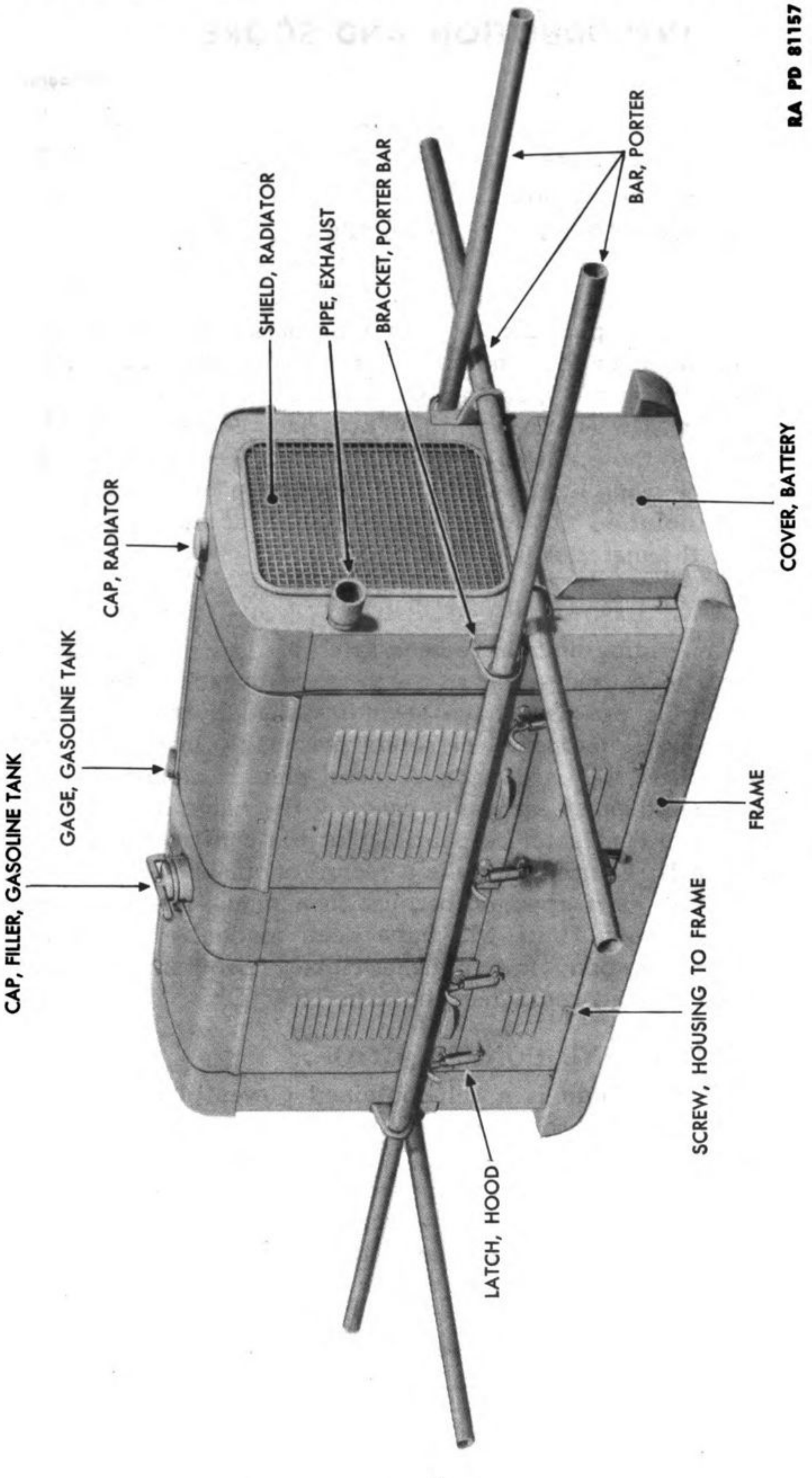
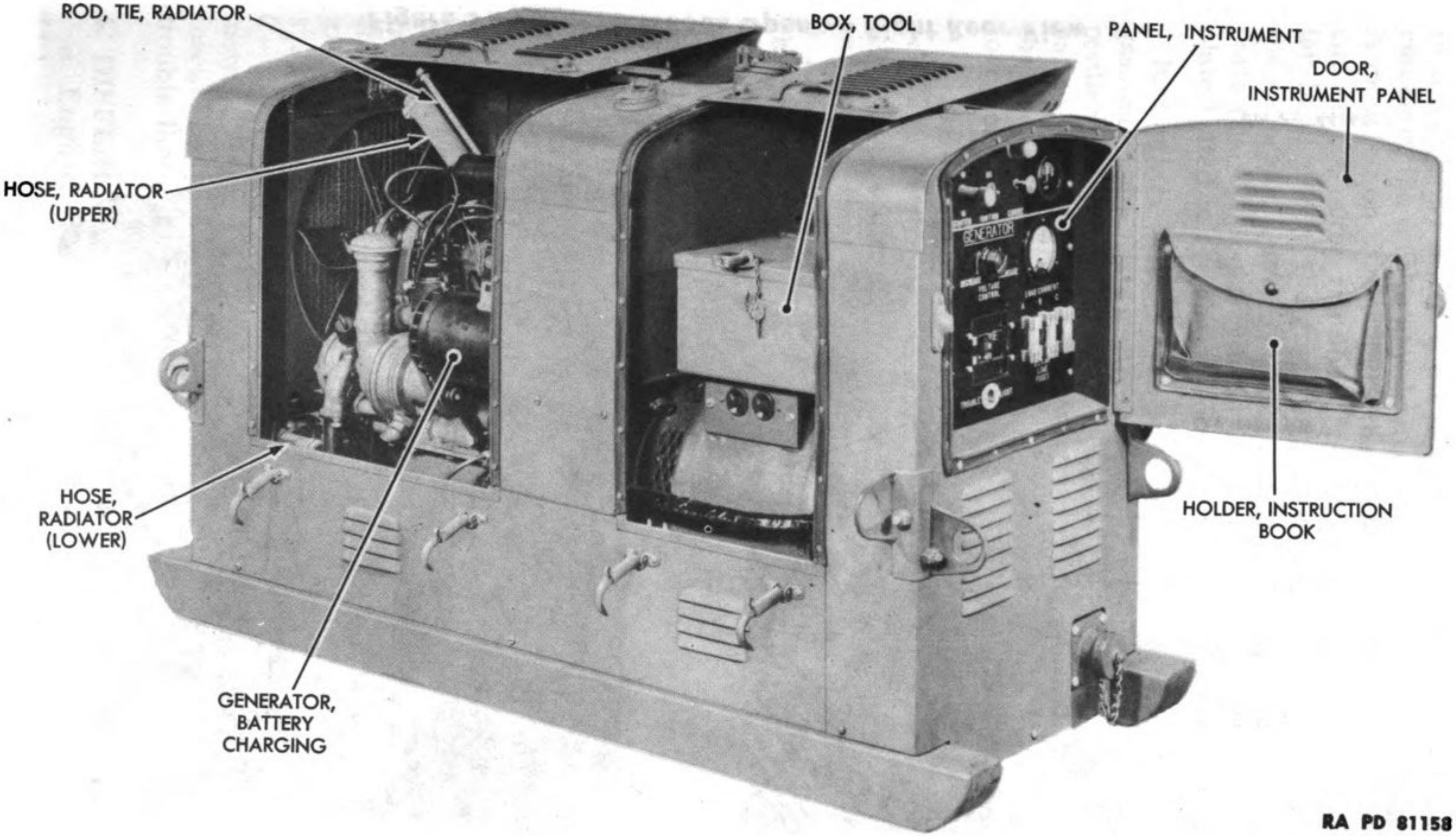
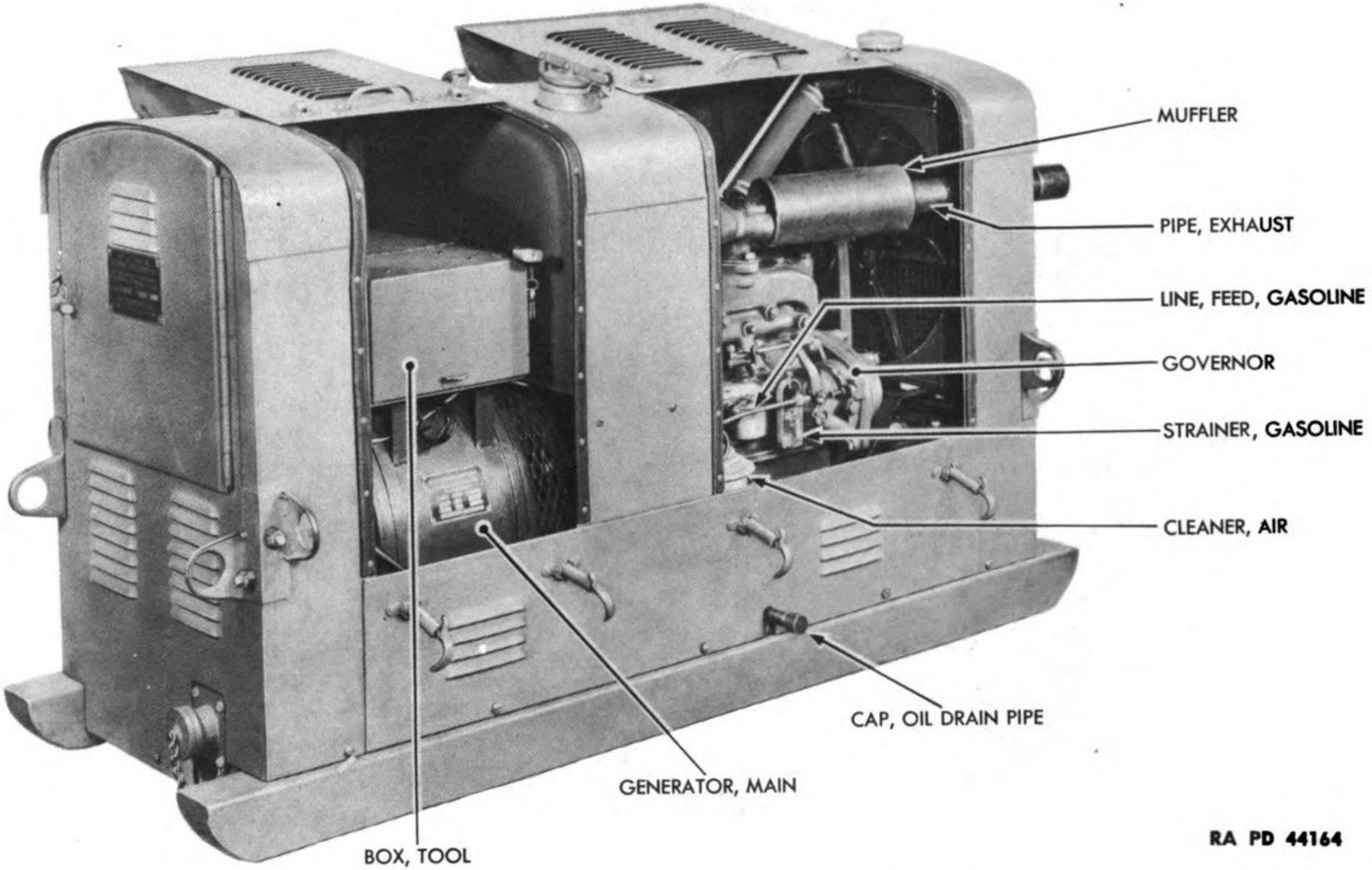

RA PD 81157
BAR, PORTER
BRACKET, PORTER BAR
PIPE, EXHAUST
SHIELD, RADIATOR
COVER, BATTERY
CAP, RADIATOR
GAGE, GASOLINE TANK
CAP, FILLER, GASOLINE TANK
FRAME
SCREW, HOUSING TO FRAME
LATCH, HOOD

Figure 1 — Unit — Porter Bars in Place — Right Front View


ROD, TIE, RADIATOR
HOSE, RADIATOR (UPPER)
HOSE, RADIATOR (LOWER)
GENERATOR, BATTERY CHARGING
BOX, TOOL
PANEL, INSTRUMENT
DOOR, INSTRUMENT PANEL
HOLDER, INSTRUCTION BOOK

RA PD 81158

Figure 2 — Unit — Hoods Open — Left Rear View


MUFFLER
PIPE, EXHAUST
LINE, FEED, GASOLINE
GOVERNOR
STRAINER, GASOLINE
CLEANER, AIR
CAP, OIL DRAIN PIPE
GENERATOR, MAIN
BOX, TOOL

RA PD 44164

Figure 3 — Unit — Hoods Open — Right Rear View

(fig. 2). Four porter bar brackets are attached to the sides and ends of the unit. By inserting porter bars in the brackets six or eight men can carry the unit to any desired location (fig. 1). The gasoline tank is mounted on the inside of the housing, and the gasoline tank filler cap on the outer, right-hand side. The gasoline tank gage is on the left-hand side of the gasoline tank (fig. 1). A tool box, mounted on the generator, serves as a container for maintenance tools and spare parts (fig. 2). Spare cylinder head gaskets are carried under a steel plate bolted to the engine hood directly over the muffler (fig. 3).

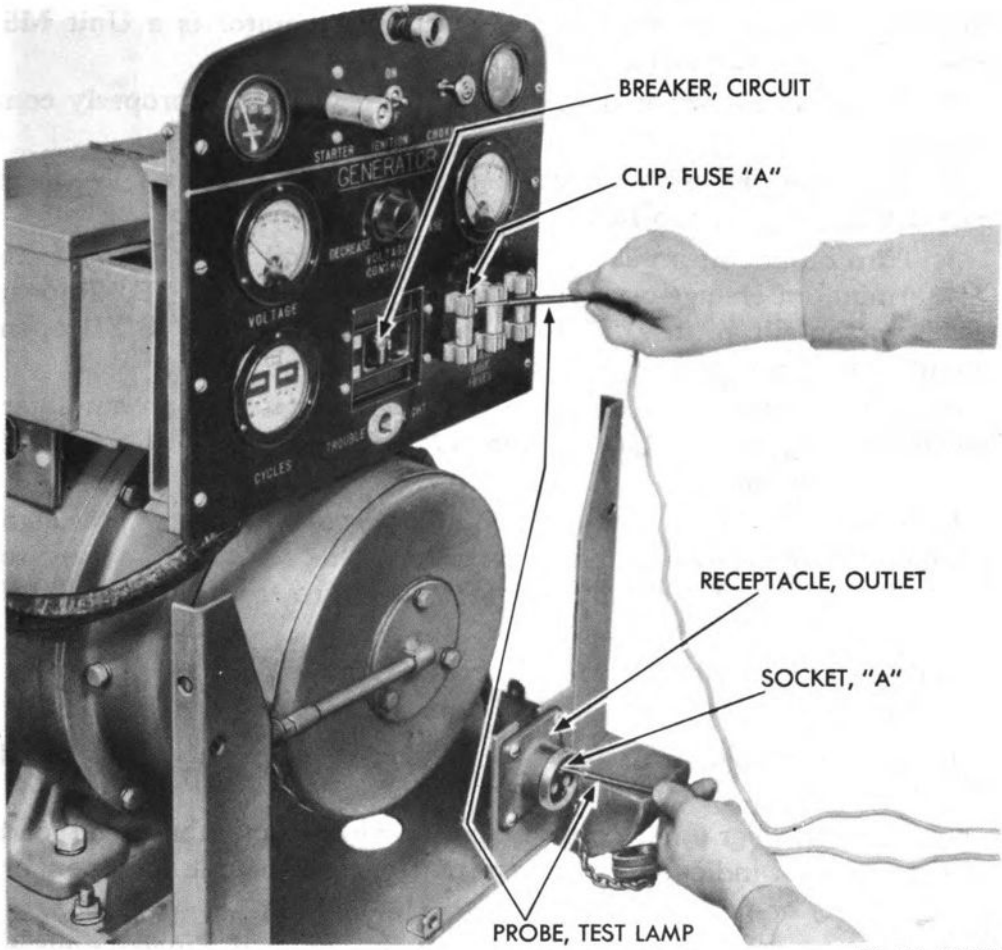
b. Engine. The 4-cylinder, 4-cycle, 11-horsepower (N.A.C.C.) gasoline engine is directly connected to the main generator by a resilient coupling. It is equipped with an electric starting motor, battery charging generator (fig. 2), oil bath air cleaner, oil filter, and gasoline strainer. Engine speeds are controlled by a mechanical governor (fig. 3).

c. Main Generator. The main generator is an alternating-current generator of the revolving field type with separate excitation provided from a direct-current generator mounted in the same housing and on the same shaft. At 1,200 revolutions per minute, it delivers 3 KVA - 13.9 amperes at 125 volts 3-phase. Adjustments on the change-over panel governor provide either 50-cycle or 60-cycle current (fig. 2). The Unit M6, serial numbers 377 to 726 inclusive, delivers 2.5 KVA - 20 amperes at 125 volts single-phase, or 3 KVA - 13.9 amperes at 125 volts 3-phase. Units M6, serial numbers 1 to 266 and 367 to 376 inclusive, deliver 2.5 KVA - 20 amperes at 125 volts, single-phase only, but can be converted to deliver 3-phase current by making certain changes in wiring (par. 29).

d. Instrument Panel. The instrument panel (figs. 2 and 65) at the rear of the unit is reached by opening the instrument panel door. Engine controls and indicators which are on the upper part of the instrument panel, consist of an oil pressure gage, starter switch, ignition toggle switch, choke control, and battery charging generator ammeter. Generator controls and indicators, on the lower part of the instrument panel are a 0 - to 150-volt alternating-current voltmeter; a 32 -ohm field rheostat (voltage control); an alternating-current 0 - to 30-ampere ammeter; a 50-to-60-cycle frequency meter (cycle meter); a 2-pole main switch including circuit breaker, and three fuses. The dash lamp is at the top of the instrument panel and the trouble lamp socket at the bottom.

4. DIFFERENCES BETWEEN UNIT M5 AND UNIT M6.

a. Engine. The Units M5 and M6 are equipped with the same 11-horsepower engine. On the Unit M6, the engine is equipped with an auxiliary governor (fig. 7). This accessory eliminates "surge" which is especially objectionable on single-phase operation.


BREAKER, CIRCUIT
CLIP, FUSE "A"
RECEPTACLE, OUTLET
SOCKET, "A"
PROBE, TEST LAMP
STARTER
IGNITION
CHOKE
ON
GENERATOR
DECREASE
VOLTAGE CONTROL
VOLTAGE
CYCLES
TROUBLE

RA PD 44129

Figure 21 — Testing "A" Circuit for Open Circuit

"A" on instrument panel to sockets 1, 2, 4, 9, 14, and 17 of the 19-pole outlet receptacle. Repeat the test from top clip of fuse "C" to sockets 10, 11, 12, 13, 16, and 19 of the 19-pole outlet receptacle. Repair or replace wiring of any circuit on which test lamp fails to light.

(c) Single-phase Unit M6.

LAMP, test

Turn on the circuit breaker. Test for open circuit (test lamp) from top clip of fuse "4" to sockets 1, 2, 4, 9, 14, and 17 of the 19-pole outlet receptacle. Repeat the test from top clip of fuse "5A" to sockets 10, 11, 12, 13, 16, and 19 of the 19-pole outlet receptacle. Repair or replace wiring of any circuit on which test lamp fails to light.

(d) Symptom—Excessive Amperes at Rated Voltage.

AMMETER LAMP, test

NOTE: This condition arises only in 3-phase generators. There-

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fore, the following steps apply whether the generator is a Unit M5 or a Unit M6 adjusted for 3-phase operation.

1. Inspect change-over panel (fig. 8) to be sure it is properly connected.

2. Test fuse "B" with a test lamp (step **b** (3) above). Replace fuse if test lamp fails to light.

3. Turn on circuit breaker. Test for open circuit (test lamp) from "B" terminal of change-over panel to bottom clip of fuse "B." Repeat test from top clip of fuse "B" to outlet receptacle socket "B." If open circuit is found, repair or replace faulty wiring or switch.

4. Test ammeter by disconnecting it and substituting an ammeter known to be good. Replace equipment ammeter if it does not read same as test ammeter.

5. If the trouble is not located and corrected in steps *1* through *4* above, an unbalanced load is probable. Check external wiring to unit for open circuit or poor connection in wire from socket "B" of outlet receptacle.

(e) Symptom—Insufficient Amperes at Rated Voltage.

LAMP, test

1. Inspect change-over panel to be sure it is properly connected (fig. 8).

2. If change-over panel connections are correct, an unbalanced load on generator is indicated. Test external wiring to unit for open or short circuits or poor connections (test lamp).

(f) No Amperes and No Voltage, Unit M5, and Single- and 3-phase Unit M6.

LAMP, test
LAMP, trouble, 110-volt
PROBE (2)

1. Start engine and turn on main switch.

2. Using a standard 110-volt trouble lamp, apply the probes at terminals "RA" and "RB" of change-over panel. Repeat test from terminals "RA" and "RC." Repeat test from terminals "RB" and "RC." Stop engine. To make this test on the single-phase Unit M6, apply the probes at "R4" and "R5" terminals of the change-over panel. Repeat test from terminals "R5" and "R5A." Stop engine.

3. If trouble lamp lights on all three tests, the generator is functioning. Proceed with steps *4* through *6* below. If trouble lamp fails to light on any two of the above tests, an open circuit in the stator or leads from stator is indicated. Disassemble generator and repair or replace stator. If trouble lamp fails to light on all three tests, proceed with steps *7* through *11* below.

4. This step applies to M5 and M6, single-phase only. For Unit M5 test for open circuit (test lamp) from change-over panel terminal

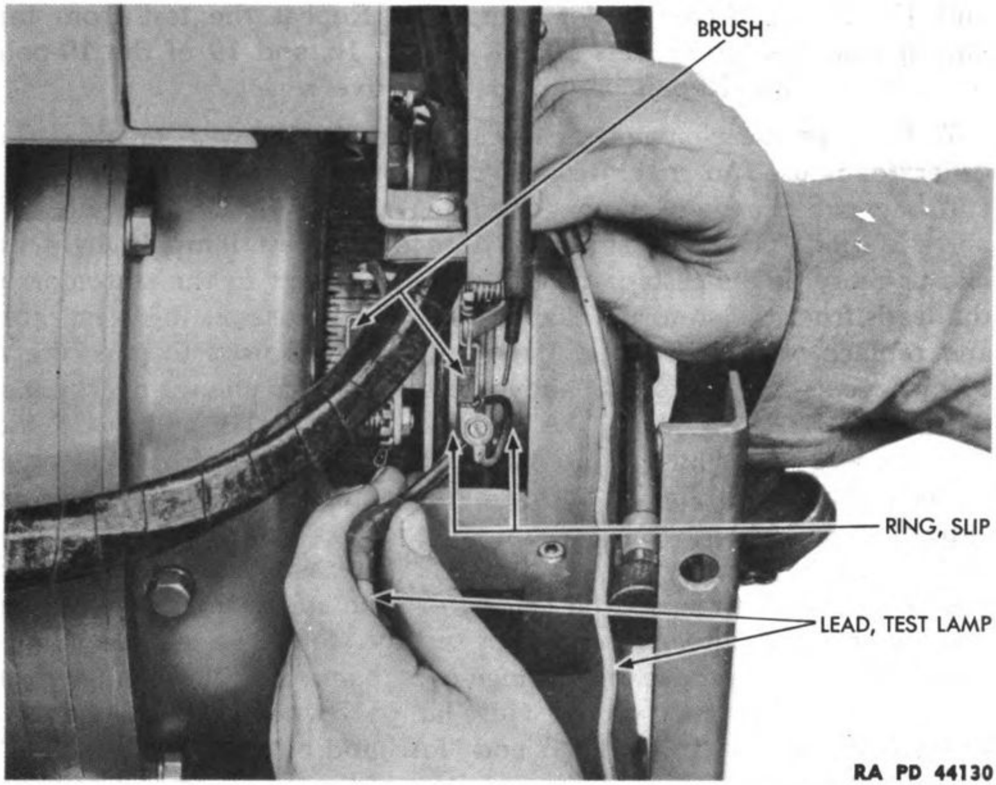

Figure 22 — Testing Revolving Field for Open Circuit

"RA" to bottom clip of fuse "A" on instrument panel. Repeat test from "RB" to bottom clip of fuse "B." Repeat test from "RC" to bottom clip of fuse "C." Repair or replace any wire having an open circuit. For Unit M6, test from terminal "RA" to bottom clip of fuse "4" on instrument panel. Repeat test from "RB" to bottom clip of fuse "5." Repeat test from "R5A" to bottom clip of fuse "5A." Repair or replace any fuse having an open circuit.

5. Test fuses with test lamp. Replace if burned out.

6. With circuit breaker on, check for open circuit from top clip of fuse "A" to socket "A" of outlet receptacle. Repeat test from "B" to "B" and from "C" to "C". Failure of test lamp to light indicates an open circuit or defective circuit breaker. Repair or replace defective parts. If the unit being tested is a single- and 3-phase Unit M6 on three-phase operation, the above steps apply. If the unit is on single-phase operation, turn on the circuit breaker. Test for an open circuit (test lamp) from top clip of fuse "A" to sockets 1, 2, 4, 9, 14, and 17 of the 19-pole outlet receptacle. Repeat the test from top clip of fuse "C" to sockets 10, 11, 12, 13, 16, and 19 of the 19-pole outlet receptacle. Repair or replace defective wiring. If the unit being tested is a single-phase Unit M6, turn on the circuit breaker. Test for open circuit (test lamp) from top clip of fuse "4" to sockets 1, 2, 4, 9, 14, and 17 of the 19-pole outlet receptacle. Repeat the test from top clip of fuse "5A" to sockets 10, 11, 12, 13, 16, and 19 of the 19-pole outlet receptacle. Repair or replace defective wiring.

7. Remove the change-over bars on the change-over panel. If the generator is used to generate a 60-cycle current test for an open circuit between change-over panel terminals "A" and "B," "A" and "C," and "B" and "C" (test lamp). Failure of the test lamp to light on one or more of the tests indicates an open circuit in the stator or in the leads from the stator to change-over panel. Disassemble generator and replace or repair stator. If the generator is used to generate a 50-cycle current, make the above tests between change-over panel terminals "1A" and "1B," "1A" and "1C," and "1B and "1C." To test single- and 3-phase Unit M6, remove the fuses from the clips on the switchboard panel. Test for an open circuit between the bottom clips of fuses "A" and "B," "A" and "C," and "B" and "C" (test lamp). Failure of the lamp to light on any of the tests indicates an open circuit in the stator or in the leads from the stator to the fuse clips. Disassemble generator and repair or replace stator. To test the single-phase Unit M6, remove the change-over bars from the change-over panel. Test for an open circuit (test lamp) between the change-over panel terminals "4" and "5," "4" and "5A," and between "5" and "5A." Failure of the lamp to light on any test indicates an open circuit in the stator or in the leads from the stator. Disassemble generator, and repair or replace stator.

8. If step *7* above reveals no open circuit, remove the brush cover (fig. 22). Lift the four slip ring brushes (narrow) in their holders so that none make contact with either slip ring. Test for open circuit between the two slip rings (test lamp) (step **b** (3) above). If test lamp fails to light, an open circuit in the revolving field or leads is indicated. Disassemble generator, and repair or replace defective coil or lead.

9. When testing the Unit M5, if step *8* above reveals no open circuit, determine whether exciter is generating current by starting engine and applying a direct-current voltmeter between any two adjacent exciter brush holders (fig. 23). During this test, set field rheostat (voltage control) at maximum increase (i.e., turn voltage control knob clockwise as far as it will go). At least 56 volts should be indicated. If no voltage is shown, connect change-over bar on change-over panel between terminals "1" and "2." Repeat test for voltage. If this step produces voltage, replace resistor back of change-over panel between terminals "1" and "2." If correct voltage is present, check wire from commutator brush to slip ring brush for open circuit or poor connection. Check wire from top slip ring brush to field rheostat (voltage control) for open circuit or poor connection. Repair or replace defective wires. NOTE: Burned insulation on these two

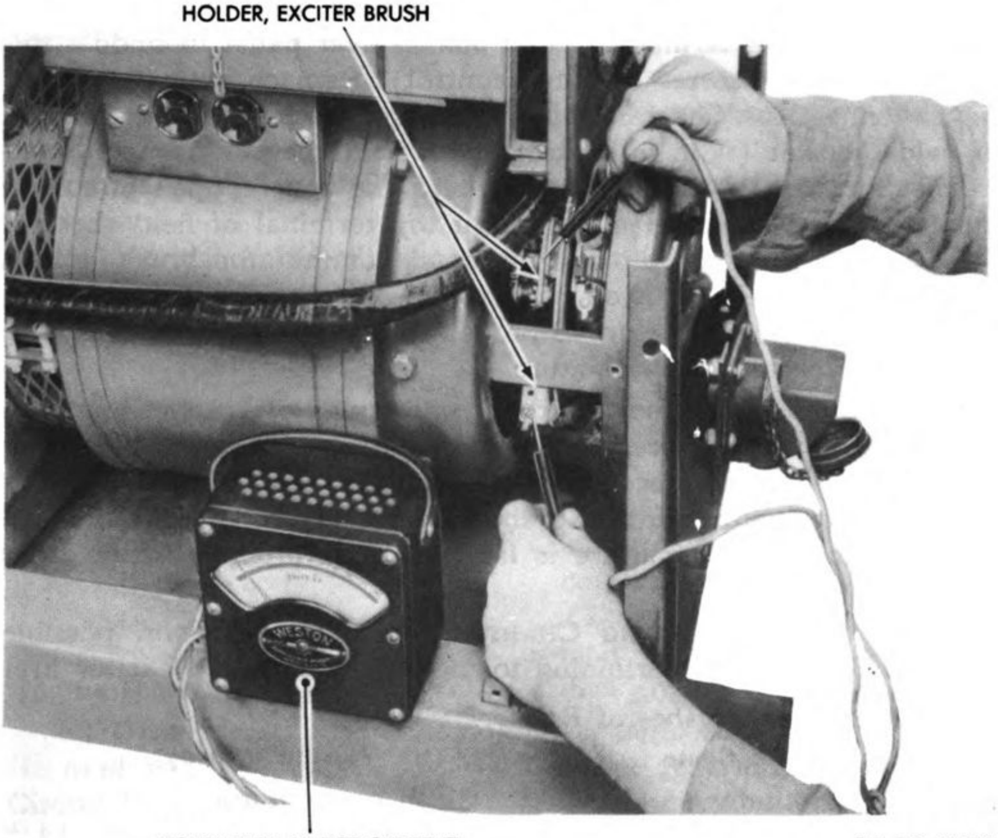

Figure 23 — Testing Exciter Voltage Output

wires indicates a short circuit in the revolving field circuit. If field is short-circuited, disassemble generator and repair or replace defective parts. This test is the same for the single-phase Unit M6, except that the change-over bar is connected between change-over panel terminals "2" and "3" instead of "1" and "2." If it is necessary to replace resistor, it is connected on rear of change-over panel between terminals "2" and "3." This test of the single- and 3-phase Unit M6 is the same as that outlined for the Unit M5, except that instead of connecting a change-over bar between change-over panel terminals "1" and "2," a wire jumper is connected across the resistor in the exciter field circuit.

10. If step *9* above shows exciter generating no voltage, examine commutator brushes to see if they are stuck in holders, broken, or worn. Replace if broken or worn. Examine brush holder springs to see that brushes are under tension and against commutator. Replace weak or broken springs. If brushes are operating satisfactorily, test for open circuit from top right-hand exciter brush to terminal "2" on change-over panel. Open circuit here indicates poor field connection on this brush holder or an open exciter field circuit. Disassemble

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generator and repair or replace open exciter field coils. Check for open circuit from terminal "2" on change-over panel to middle terminal on field rheostat (voltage control). Replace wire if open or repair connections. Check for open circuit from top to middle terminal of field rheostat (voltage control) with field rheostat turned to extreme clockwise position. Replace field rheostat if open circuit is indicated. Test for open circuit from top terminal of field rheostat (voltage control) to bottom right-hand commutator brush holder. Repair or replace wire if open. If above procedure reveals no fault, a defective exciter armature is probable. Disassemble generator and repair or replace exciter armature.

11. If step *9* above shows exciter generating voltage, but less than 56 volts, follow the procedure outlined in step *10* above. Look especially for a high resistance or loose connection, faulty resistor, faulty field rheostat (voltage control), short circuit in exciter field coil, or a faulty armature. If armature is faulty, it will probably show signs of heat.

(7) TROUBLE SHOOTING CHART. Possible malfunctions, possible causes, and remedies pertaining to main generator and exciter are:

(a) Arcing at Brushes of Exciter.

Possible Cause	**Possible Remedy**
Dirt on commutator.	Clean commutator.
Worn brushes.	Replace brushes (par. 24 **b** (10)).
Brushes stuck in holders.	Remove, clean, and install brush holder and brush (pars. 24 **b** (9) and (10) and 27 **b** (1) through (4)).
Open circuit in armature coil in exciter.	Replace armature (par. 24).
Open circuit in main generator lead to field rheostat.	Solder lead (par. 26 **b** (1) *(b)* *1*).

(b) Fails to Generate Rated Amperes.

Unbalanced load on lines.	Balance load on lines.
Defective wiring in circuit.	Replace or repair wiring (par. 24).
Bars on change-over panel connected incorrectly.	Connect change-over panel bars correctly (par. 29 **b** (1) and (2)).
Field rheostat incorrectly adjusted.	Adjust field rheostat correctly.
Dirt on exciter commutator.	Clean exciter commutator.
Worn brushes on exciter.	Replace exciter brushes.
Defective rotor.	Replace rotor (par. 24 **a** through **b** (4)).

Possible Cause	Possible Remedy
Short circuit in revolving field coil.	Replace revolving field coil (par. 24 **a** through **b** (7)).
Open circuit in revolving field coil.	Replace revolving field coil (par. 24 **a** through **b** (7)).
Grounded revolving field coil.	Replace revolving field coil (par. 24 **a** through **b** (7)).
Open circuit in field coil lead.	Solder field coil lead (par. 26 **b** (1) *(a) 1*).
Short circuit in field coil lead.	Replace field coil lead (par. 26 **b** (1) *(a) 3*).
Fuse burned out.	Replace burned out fuse.
No load on generator.	Put load on generator.
Defective ammeter.	Replace ammeter (par. 36).

(c) Fails to Operate at Proper Frequency.

Possible Cause	Possible Remedy
Bars on change-over panel connected incorrectly.	Connect change-over panel bars correctly (par. 29 **b** (1) and (2)).
Defective wiring in circuit.	Repair wiring (par. 26 **b** (1)).
Engine speed too low or too high.	Adjust engine speed (par. 148),

(d) Generator Delivers No Voltage or Amperage.

Possible Cause	Possible Remedy
No load on generator.	Connect generator to load.
Circuit breaker off.	Turn on circuit breaker.
Dirt on commutator of exciter.	Clean commutator.
Exciter brushes stuck in holders.	Remove, clean, and install brush holder and brush (pars. 24 **b** (9) and (10) and 27 **b** (1) through (4)).
Worn exciter brushes.	Replace exciter brushes.
Open circuit in revolving field coil.	Replace revolving field coil (par. 24 **a** through **b** (7)).
Open circuit in field coil lead.	Connect and solder field coil lead par. 26 **b** (1) *(a)*).
Defective rotor.	Replace rotor (par. 24 **a** through **b** (4)).
Grounded revolving field coil.	Replace revolving field coil (par. 24 **a** through **b** (7)).
Fuses blown out.	Replace fuses.
Change-over panel incorrectly connected.	Connect change-over panel correctly (pars. 27 **b** (11) *(e)* and 29 **b** (1) and (2)).
Open circuit in stator winding.	Replace body and stator (par. 24 **b** (1) through (5)).
Open circuit in wiring from change-over panel to instrument panel.	Test (par. 22 **b** (6) *(d)*) and repair or replace welding.

Possible Cause	Possible Remedy
Open circuit between stator and change-over panel.	Test (par. 22 **b** (6) *(d)*) and repair or replace wiring.

(e) Generator Delivers No Voltage.

Possible Cause	Possible Remedy
Defective voltmeter.	Replace voltmeter (par. 35).
Change-over panel improperly connected.	Connect change-over panel properly (par. 27 **b** (11) *(e)*).
Change-over panel bars not connected.	Connect change-over panel bars (par. 29 **b** (1) and (2)).

(f) Voltmeter Shows No Voltage.

Possible Cause	Possible Remedy
Fuse "A" burned out.	Replace fuse "A."
Open circuit in circuit "A."	Replace or repair wiring (par. 24).
Defective voltmeter.	Replace voltmeter (par. 35).

(g) Ammeter Registers Too High.

Possible Cause	Possible Remedy
Defective ammeter.	Replace ammeter (par. 36).
Fuse "B" burned out.	Replace fuse "B."
Open circuit in "B" circuit.	Repair or replace wiring (par. 24).
Change-over panel incorrectly connected.	Connect change-over panel correctly (par. 27 **b** (11) *(e)*).
Improperly balanced load.	Balance load.

23. REMOVAL.

a. Equipment.

HOIST, chain
SCREWDRIVER
WRENCH, open-end, ⅜-in.
WRENCH, open-end, ½-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, ¾-in.
WRENCH, Stillson

b. Procedure.

(1) Remove housing (par. 14).

(2) Disconnect starter switch to starting motor cable from starting motor (9/16-in. open-end wrench).

(3) Remove the wire from the ammeter to battery charging generator regulator at the regulator (screwdriver) (fig. 133).

(4) Remove ignition switch to ignition coil wire from ignition coil terminal marked "—" (⅜-in. open-end wrench) (fig. 133).

(5) Disconnect choke control from carburetor and air cleaner bracket (par. 154).

(6) Disconnect oil pressure gage line from cylinder block (½-in. open-end wrench) (fig. 133).

(7) Remove main generator front grease cup (½-in. open-end wrench). Remove main generator front grease cup elbow and nipple (Stillson wrench) (fig. 133).

MAIN GENERATOR AND EXCITER

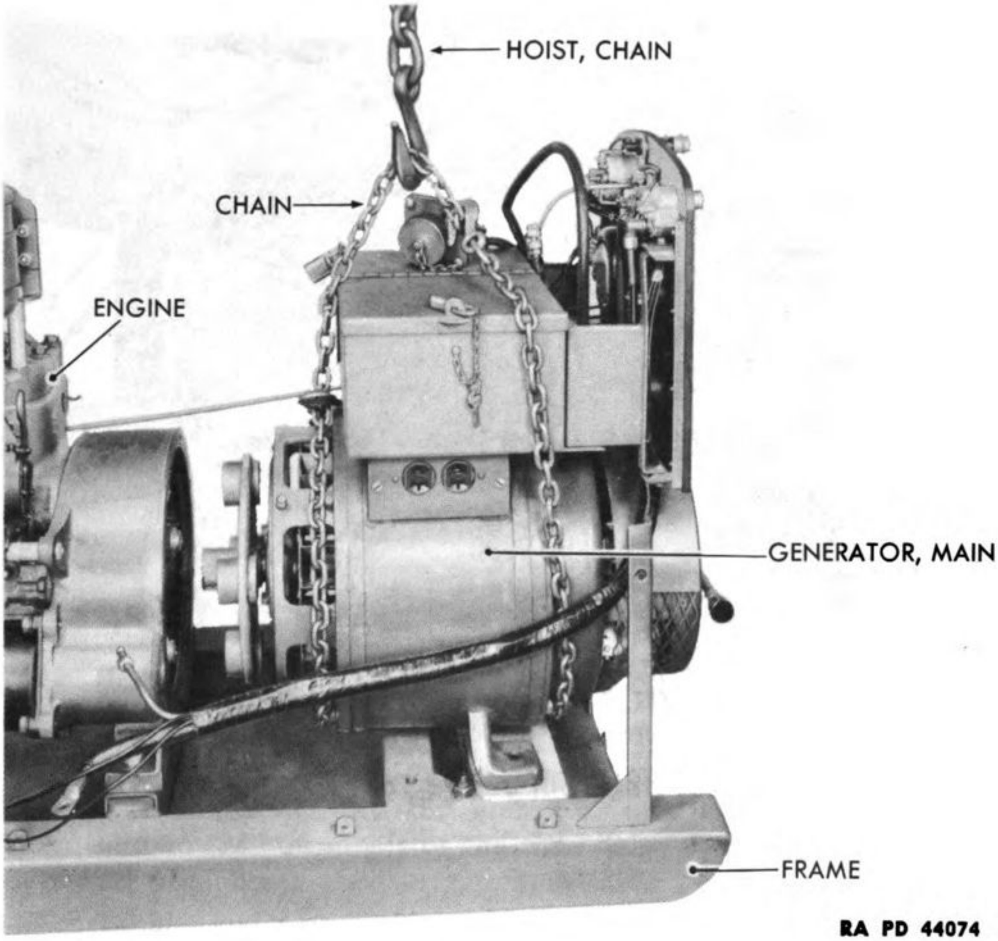

Figure 24 — Lifting Main Generator from Unit

(8) Remove main generator fan cover clamp screws and nuts (screwdriver). Lift fan cover from unit (fig. 133).

(9) Remove eight cap screws and lock washers securing main generator to bell housing ($^9/_{16}$-in. open-end wrench) (fig. 134).

(10) Remove outlet receptacle (pars. 62 and 63).

(11) Loosen right-hand engine rear mounting cap screw (¾-in. open-end wrench). Pull battery to starter switch cable from cable clip (fig. 135).

(12) Remove main generator mounting cap screws and lock washers (¾-in. open-end wrench) (fig. 134).

(13) Slide back entire main generator and instrument panel assembly until it clears engine (two men).

(14) Construct a chain or rope sling and carefully lift main generator and instrument panel assembly from unit with a chain hoist (fig. 24).

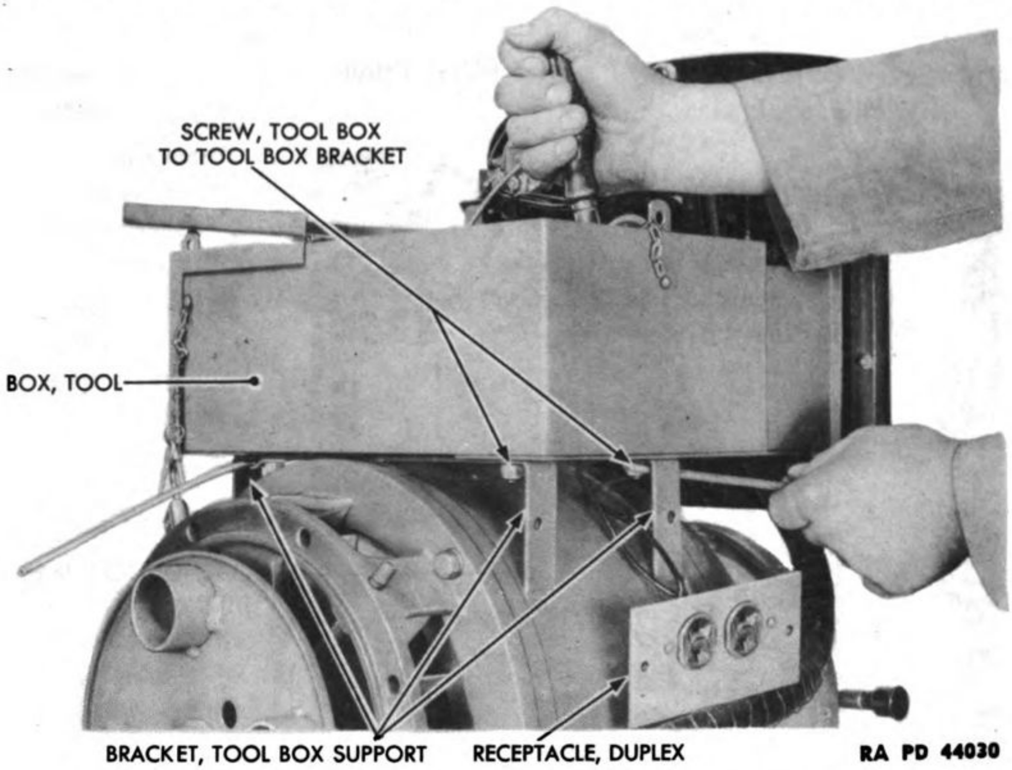
SCREW, TOOL BOX TO TOOL BOX BRACKET
BOX, TOOL
BRACKET, TOOL BOX SUPPORT
RECEPTACLE, DUPLEX
RA PD 44030

Figure 25 — Removing Tool Box to Tool Box Bracket Screws

24. DISASSEMBLY.

a. Equipment.

- CUTTER, wire
- HAMMER, soft
- HAMMER, 2-lb
- MALLET, rawhide
- PULLER, bearing
- PULLER, gear
- SCREWDRIVER
- SCREWDRIVER, large
- TAG, cardboard (6)
- WRENCH, open-end, 5/16-in.
- WRENCH, open-end, 11/32-in.
- WRENCH, open-end, 7/16-in.
- WRENCH, open-end, 1/2-in.
- WRENCH, open-end, 9/16-in.
- WRENCH, socket, 1/2-in.
- WRENCH, socket, 9/16-in.
- WRENCH, socket-head setscrew, 1/8-in.
- WRENCH, socket-head setscrew, 5/16-in.
- WRENCH, Stillson

b. Procedure.

(1) REMOVE INSTRUMENT PANEL, TOOL BOX, AND CHANGE-OVER PANEL.

- SCREWDRIVER
- WRENCH, open-end, 5/16-in.
- WRENCH, open-end, 7/16-in.
- WRENCH, open-end, 1/2-in.

(a) Unit M5. Disconnect main generator leads from back of change-over panel terminals "1," "1A," "1B," "1C," "A," "B," and "C" (1/2-in. open-end wrench) (fig. 71).

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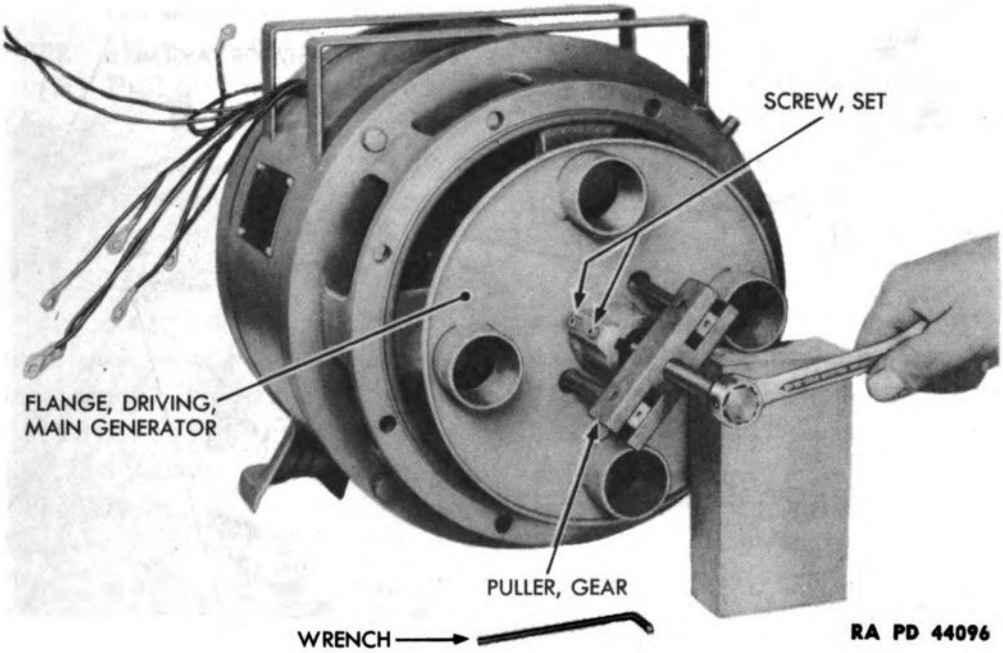

Figure 26 — Pulling Main Generator Driving Flange

(b) Single-phase Unit M6. Disconnect main generator leads from back of terminals "2," "4," "5," and "5A" of change-over panel, and from the two "M" terminals of the time delay relay (7/16- and 3/8-in. open-end wrenches).

(c) Single- and 3-phase Unit M6. Disconnect main generator leads from bottom clips of fuses "A," "B," and "C," and from the two "M" terminals of the time delay relay (7/16-in. open-end wrench).

(d) Disconnect main generator leads (5/16-in. open-end wrench) (fig. 66) from top terminal of field rheostat (voltage control).

(e) Remove screws and safety nuts (1/2-in. open-end wrench and screwdriver), securing tool box to right-hand bracket.

(f) Remove duplex receptacle to tool box bracket screws, nuts, and lock washers (screwdriver and 7/16-in. open-end wrench). Lift receptacle from bracket (fig. 74).

(g) Remove screws and safety nut which secure tool box to left-hand bracket (1/2-in. open-end wrench and screwdriver).

(h) Lift instrument panel, tool box, and change-over panel assembly from generator. CAUTION: Duplex receptacle must be pushed through tool box bracket as assembly is lifted from generator (fig. 74).

(2) REMOVE MAIN GENERATOR DRIVING FLANGE.

HAMMER, 2-lb
PULLER, gear
WRENCH, socket-head setscrew, 1/8-in.

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